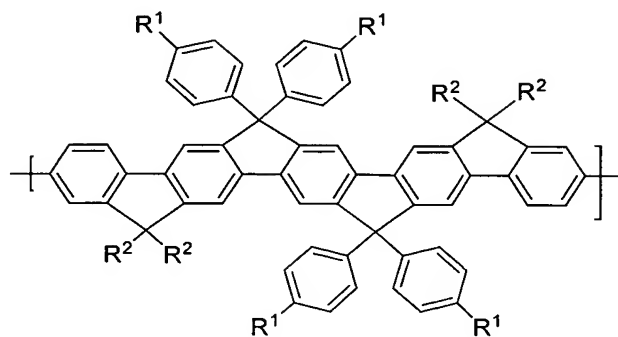


CLAIMS

What is claimed is:

1. A copolymer comprising at least one monomeric unit having Formula I:

5



(I)

wherein:

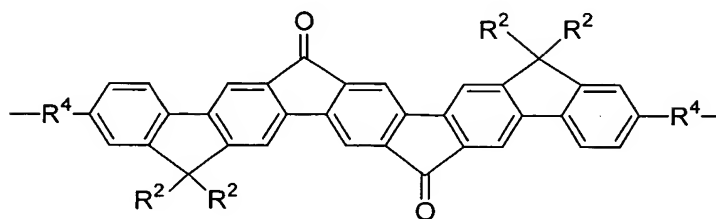
R^1 is the same or different at each occurrence and is selected from hydrogen, C_1 - C_{20} alkyl, C_2 - C_{20} alkenyl, C_2 - C_{20} alkynyl, C_1 - C_{20} alkoxy, C_1 - C_{20} oxyalkyl, C_2 - C_{20} oxyalkenyl, C_2 - C_{20} oxyalkynyl, C_1 - C_{20} fluorinated alkyl, C_2 - C_{20} fluorinated alkenyl, C_1 - C_{20} fluorinated oxyalkyl, C_2 - C_{20} fluorinated oxyalkenyl, C_2 - C_{20} fluorinated oxyalkynyl, aryl, heteroalkyl, heteroalkenyl, heteroalkynyl, heteroaryl, -CN, -OR³, -CO₂R³, -SR³, -N(R³)₂, -P(R³)₂, -SOR³, -SO₂R³, and -NO₂; or adjacent R groups together can form a 5- or 6-membered cycloalkyl, aryl, or heteroaryl ring,

R^2 is the same or different at each occurrence and is selected from C_1 - C_{20} alkyl, C_2 - C_{20} alkenyl, C_2 - C_{20} alkynyl, C_1 - C_{20} alkoxy, C_1 - C_{20} oxyalkyl, C_2 - C_{20} oxyalkenyl, C_2 - C_{20} oxyalkynyl, C_1 - C_{20} fluorinated alkyl, C_2 - C_{20} fluorinated alkenyl, C_1 - C_{20} fluorinated oxyalkyl, C_2 - C_{20} fluorinated oxyalkenyl, C_2 - C_{20} fluorinated oxyalkynyl, heteroalkyl, heteroalkenyl, heteroalkynyl, -CN, -OR³, -CO₂R³, -SR³, -N(R³)₂, -P(R³)₂, -SOR³, -SO₂R³, and -NO₂; or adjacent R groups together can form a 5- or 6-membered cycloalkyl or heterocycloalkyl ring, and

R^3 is a substituent on a heteroatom which can be the same or different at each occurrence and is selected from hydrogen, alkyl, aryl, heteroalkyl and heteroaryl;

and at least one second monomeric unit comprising an aromatic group.

2. A copolymer according to Claim 1, wherein the second monomeric unit has Formula II:



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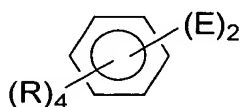
(II)

wherein:

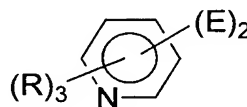
- R^2 is the same or different at each occurrence and is selected from C_1 - C_{20} alkyl, C_2 - C_{20} alkenyl, C_2 - C_{20} alkynyl, C_1 - C_{20} alkoxy, C_1 - C_{20} oxyalkyl, C_2 - C_{20} oxyalkenyl, C_2 - C_{20} oxyalkynyl, C_1 - C_{20} fluorinated alkyl, C_2 - C_{20} fluorinated alkenyl, C_1 - C_{20} fluorinated oxyalkyl, C_2 - C_{20} fluorinated oxyalkenyl, C_2 - C_{20} fluorinated oxyalkynyl, heteroalkyl, heteroalkenyl, heteroalkynyl, -CN, -OR³, -CO₂R³, -SR³, -N(R³)₂, -P(R³)₂, -SOR³, -SO₂R³, and -NO₂; or adjacent R groups together can form a 5- or 6-membered cycloalkyl or heterocycloalkyl ring, and

R^4 is the same or different at each occurrence and is selected from a single bond, alkylene, arylene, heteroalkylene, and heteroarylene.

3. A copolymer according to Claim 1, wherein the second monomeric unit has a formula selected from Formula III through Formula XII and combinations thereof,



(III)

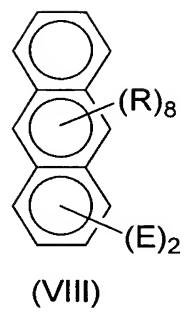
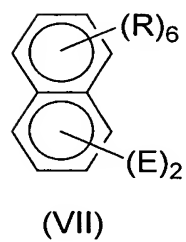
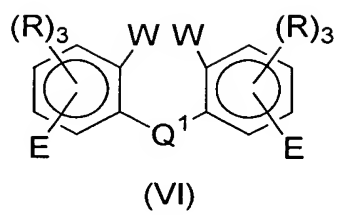


(IV)

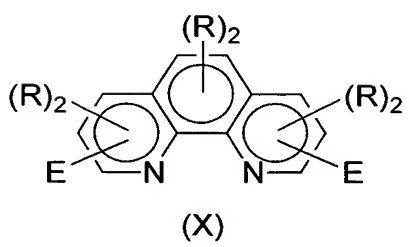
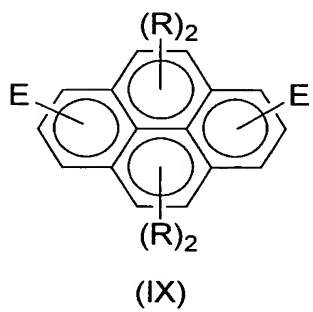
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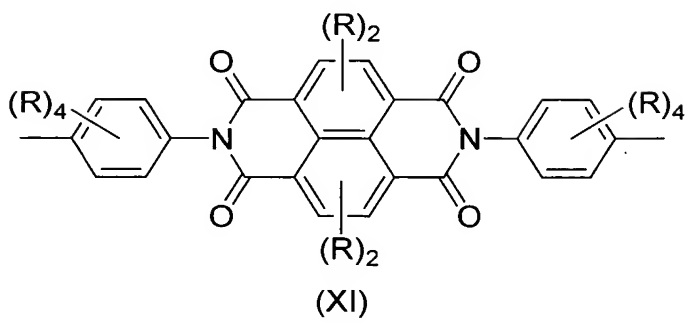
(V)

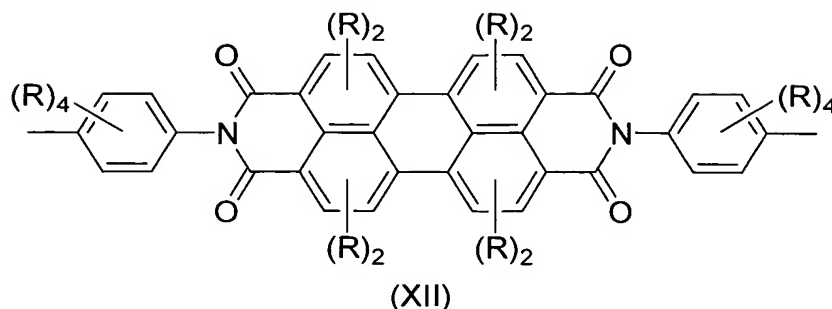


5



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5 where:

in each of Formulae III through XII:

R is a substituent on a carbon atom which can be the same or different at each occurrence and is selected from hydrogen, C₁-C₂₀ alkyl, C₂-C₂₀ alkenyl, C₂-C₂₀ alkynyl, C₁-C₂₀ alkoxy, C₁-C₂₀ oxyalkyl, C₂-C₂₀ oxyalkenyl, C₂-C₂₀ oxyalkynyl, C₁-C₂₀ fluorinated alkyl, C₂-C₂₀ fluorinated alkenyl, C₁-C₂₀ fluorinated oxyalkyl, C₂-C₂₀ fluorinated oxyalkenyl, C₂-C₂₀ fluorinated oxyalkynyl, aryl, heteroalkyl, heteroalkenyl, heteroalkynyl, heteroaryl, -CN, -OR³, -CO₂R³, -SR³, -N(R³)₂, -P(R³)₂, -SOR³, -SO₂R³, and -NO₂; or adjacent R groups together can form a 5- or 6-membered cycloalkyl, aryl, or heteroaryl ring;

R³ is a substituent on a heteroatom which can be the same or different at each occurrence and is selected from hydrogen, alkyl, aryl, heteroalkyl and heteroaryl

in each of Formulae III, IV, V, VI, VII, VIII, IX and X:

E can be the same or different at each occurrence and is a single bond or a linking group selected from arylene and heteroarylene; in Formula V:

A is independently at each occurrence C or N and γ is 0 or an integer selected from 1 or 2, such that when both A are N, then γ is 0; or when one of A is N and one of A is C, then γ is 1; or when both A are C, then γ is 2;

Q is O, S, SO₂, or NR³ where:

R³ is a substituent on a heteroatom which can be the same or different at each occurrence and is selected from hydrogen, alkyl, aryl, heteroalkyl and heteroaryl;

in Formula VI:

Q¹ is a carbonyl group, O, S, SO₂, or NR³ where:

R^3 is a substituent on a heteroatom which can be the same or different at each occurrence and is selected from hydrogen, alkyl, aryl, heteroalkyl and heteroaryl;

W is H, alkyl or heteroalkyl; or both of W together can represent one single bond;

in Formula VII:

the two E's are in the 1,4-, 1,5-, 1,8-, 2,3-, or 2,6- positions;

in Formula VIII:

the two E's are in the 1,4-, 1,5-, 1,8-, 2,3-, 2,6-, or 9,10- positions;

in Formula IX:

a first E is in the 1, 2, or 3 position, a second E is in the 6, 7, or 8 position; and

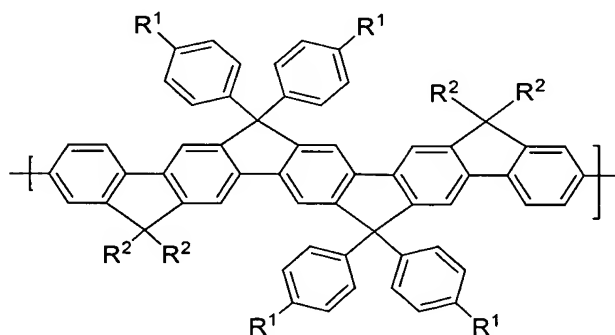
in Formula X:

a first E is in the 2, 3, or 4 position; a second E is in the 7, 8, or 9 position.

4. A copolymer according to Claim 1, wherein R^1 is a C_1 - C_{20} alkyl.

5. A copolymer according to Claim 1, wherein R^2 is a C_1 - C_{20} alkyl.

6. An electronic device comprising an active layer positioned between two electrical contact layers, wherein the active layer comprises a copolymer comprising at least one monomeric unit having Formula I:



(I)

wherein:

R^1 is the same or different at each occurrence and is selected from hydrogen, C_1 - C_{20} alkyl, C_2 - C_{20} alkenyl, C_2 - C_{20} alkynyl, C_1 - C_{20} alkoxy, C_1 - C_{20} oxyalkyl, C_2 - C_{20} oxyalkenyl, C_2 - C_{20} oxyalkynyl, C_1 - C_{20} fluorinated alkyl, C_2 - C_{20} fluorinated alkenyl, C_1 - C_{20} fluorinated oxyalkyl, C_2 - C_{20} fluorinated oxyalkenyl, C_2 - C_{20} fluorinated oxyalkynyl, aryl,

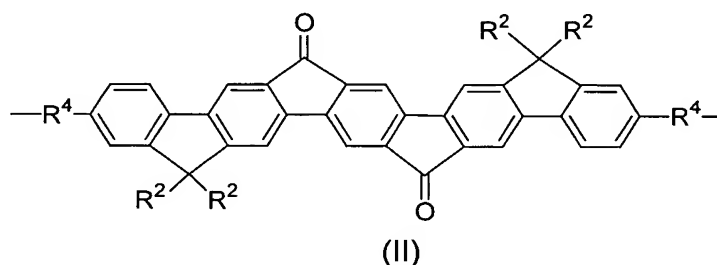
heteroalkyl, heteroalkenyl, heteroalkynyl, heteroaryl, -CN, -OR³, -CO₂R³, -SR³, -N(R³)₂, -P(R³)₂, -SOR³, -SO₂R³, and -NO₂; or adjacent R groups together can form a 5- or 6-membered cycloalkyl, aryl, or heteroaryl ring,

R² is the same or different at each occurrence and is selected from C₁-C₂₀ alkyl, C₂-C₂₀ alkenyl, C₂-C₂₀ alkynyl, C₁-C₂₀ alkoxy, C₁-C₂₀ oxyalkyl, C₂-C₂₀ oxyalkenyl, C₂-C₂₀ oxyalkynyl, C₁-C₂₀ fluorinated alkyl, C₂-C₂₀ fluorinated alkenyl, C₁-C₂₀ fluorinated oxyalkyl, C₂-C₂₀ fluorinated oxyalkenyl, C₂-C₂₀ fluorinated oxyalkynyl, heteroalkyl, heteroalkenyl, heteroalkynyl, -CN, -OR³, -CO₂R³, -SR³, -N(R³)₂, -P(R³)₂, -SOR³, -SO₂R³, and -NO₂; or adjacent R groups together can form a 5- or 6-membered cycloalkyl or heterocycloalkyl ring, and

R³ is a substituent on a heteroatom which can be the same or different at each occurrence and is selected from hydrogen, alkyl, aryl, heteroalkyl and heteroaryl.

7. An electronic device according to Claim 6, wherein the copolymer further comprises at least one second monomeric unit comprising an aromatic group.

8. An electronic device according to Claim 7, wherein the second monomeric unit has Formula II:

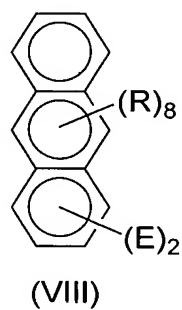
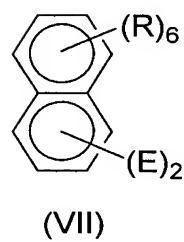
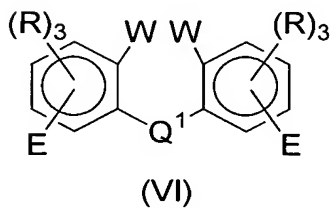
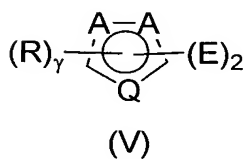
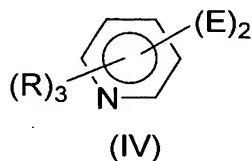
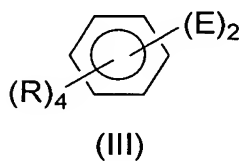


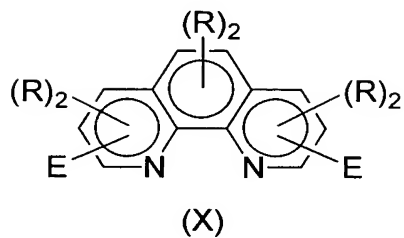
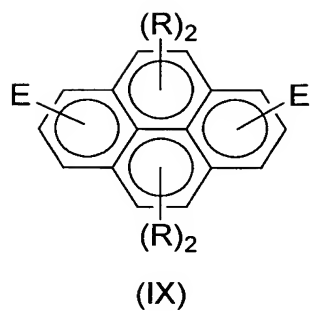
wherein:

R² is the same or different at each occurrence and is selected from C₁-C₂₀ alkyl, C₂-C₂₀ alkenyl, C₂-C₂₀ alkynyl, C₁-C₂₀ alkoxy, C₁-C₂₀ oxyalkyl, C₂-C₂₀ oxyalkenyl, C₂-C₂₀ oxyalkynyl, C₁-C₂₀ fluorinated alkyl, C₂-C₂₀ fluorinated alkenyl, C₁-C₂₀ fluorinated oxyalkyl, C₂-C₂₀ fluorinated oxyalkenyl, C₂-C₂₀ fluorinated oxyalkynyl, heteroalkyl, heteroalkenyl, heteroalkynyl, -CN, -OR³, -CO₂R³, -SR³, -N(R³)₂, -P(R³)₂, -SOR³, -SO₂R³, and -NO₂; or adjacent R groups together can form a 5- or 6-membered cycloalkyl or heterocycloalkyl ring, and

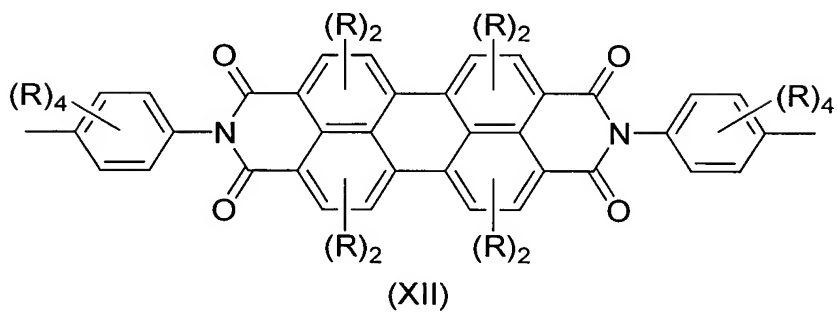
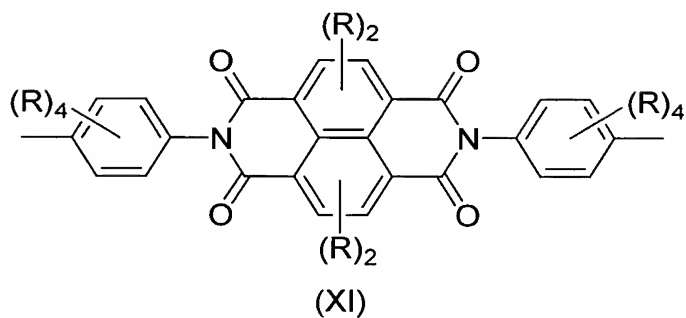
R⁴ is the same or different at each occurrence and is selected from a single bond, alkylene, arylene, heteroalkylene, and heteroarylene.

9. An electronic device according to Claim 7, wherein the second monomeric unit has a formula selected from Formula III through Formula XII and combinations thereof,





5



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where:

in each of Formulae III through XII:

15

R is a substituent on a carbon atom which can be the same or different at each occurrence and is selected from hydrogen, C₁-C₂₀ alkyl, C₂-C₂₀ alkenyl, C₂-C₂₀ alkynyl, C₁-C₂₀ alkoxy, C₁-C₂₀ oxyalkyl, C₂-C₂₀

oxyalkenyl, C₂-C₂₀ oxyalkynyl, C₁-C₂₀ fluorinated alkyl, C₂-C₂₀ fluorinated alkenyl, C₁-C₂₀ fluorinated oxyalkyl, C₂-C₂₀ fluorinated oxyalkenyl, C₂-C₂₀ fluorinated oxyalkynyl, aryl, heteroalkyl, heteroalkenyl, heteroalkynyl, heteroaryl, -CN, -OR³, -CO₂R³, -SR³, -N(R³)₂, -P(R³)₂, -SOR³, -SO₂R³, and -NO₂; or adjacent R groups together can form a 5- or 6-membered cycloalkyl, aryl, or heteroaryl ring;

R³ is a substituent on a heteroatom which can be the same or different at each occurrence and is selected from hydrogen, alkyl, aryl, heteroalkyl and heteroaryl

10 in each of Formulae III, IV, V, VI, VII, VIII, IX and X:

E can be the same or different at each occurrence and is a single bond or a linking group selected from arylene and heteroarylene; in Formula V:

15 A is independently at each occurrence C or N and γ is 0 or an integer selected from 1 or 2, such that when both A are N, then γ is 0; or when one of A is N and one of A is C, then γ is 1; or when both A are C, then γ is 2;

Q is O, S, SO₂, or NR³ where:

20 R³ is a substituent on a heteroatom which can be the same or different at each occurrence and is selected from hydrogen, alkyl, aryl, heteroalkyl and heteroaryl; in Formula VI:

Q¹ is a carbonyl group, O, S, SO₂, or NR³ where:

25 R³ is a substituent on a heteroatom which can be the same or different at each occurrence and is selected from hydrogen, alkyl, aryl, heteroalkyl and heteroaryl;

W is H, alkyl or heteroalkyl; or both of W together can represent one single bond;

in Formula VII:

30 the two E's are in the 1,4-, 1,5-, 1,8-, 2,3-, or 2,6- positions; in Formula VIII:

the two E's are in the 1,4-, 1,5-, 1,8-, 2,3-, 2,6-, or 9,10- positions;

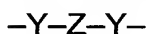
in Formula IX:

35 a first E is in the 1, 2, or 3 position, a second E is in the 6, 7, or 8 position; and

in Formula X:

a first E is in the 2, 3, or 4 position; a second E is in the 7, 8, or 9 position.

10. An electronic device according to Claim 7, wherein the second monomeric unit has a formula



wherein:

Y is an aromatic group with at least one substituent selected from alkyl, heteroalkyl, aryl, arylalkyl, heteroaryl, heteroarylalkyl, and NR^5 ,

10 R^5 is H or an alkyl; and

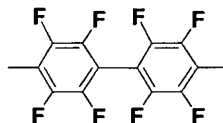
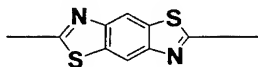
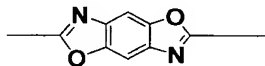
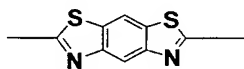
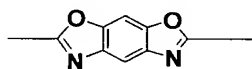
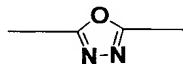
Z is an electron deficient group.

11. An electronic device according to Claim 10, wherein Y is selected from fluorenes, spirofluorenes, phenyls, biphenyls, bridged biphenyls, naphthalenes, anthracenes, and combinations thereof.

- 15 12. An electronic device according to Claim 10, wherein Z is selected from oxazole-type groups, oxadiazole-type groups, thiazole-type groups, fluorinated aromatic groups, and combinations thereof.

13. An electronic device according to Claim 10, wherein Z is selected from:

20



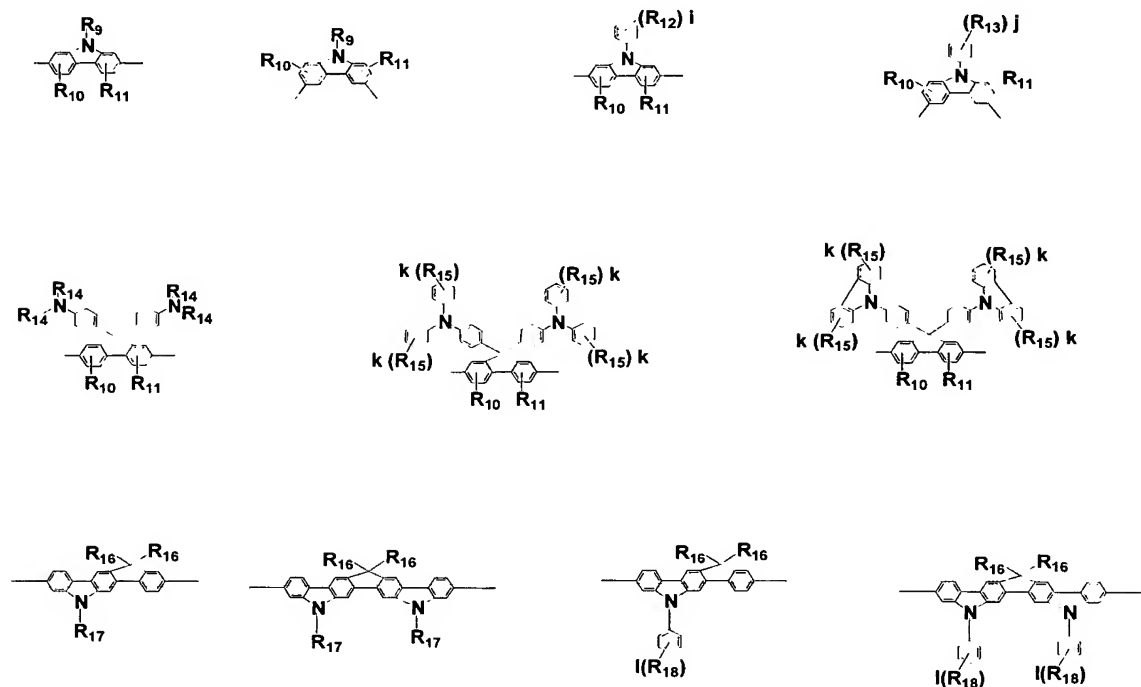
14. An electronic device according to Claim 7, wherein the second monomeric unit has hole transport properties.

- 25 15. An electronic device according to Claim 14, wherein the second monomeric unit is selected from carbazoles, triaryl amines, aromatic

groups having carbazole groups, aromatic groups having triarylamine groups, and combinations thereof.

16. An electronic device according to Claim 14, wherein the second monomeric unit is selected from:

5



wherein:

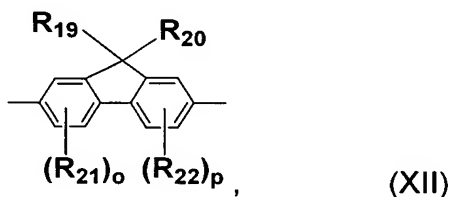
R9-R18 are same or different and are selected from alkyl, heteroalkyl, aryl, arylalkyl, heteroaryl, heteroarylalkyl, and NR⁵,
 10 R⁵ is H or an alkyl;

i, j, k, l are numbers of substituents on the benzene rings and are same or different and each of i, j, k, and l is in a range of 0-3.

17. An electronic device according to Claim 7, wherein the second monomeric unit is selected from substituted fluorenes, substituted phenyls, substituted biphenyls, substituted bridged biphenyls, and combinations thereof.

18. An electronic device according to Claim 7, wherein the second monomeric unit has Formula XII:

20



wherein

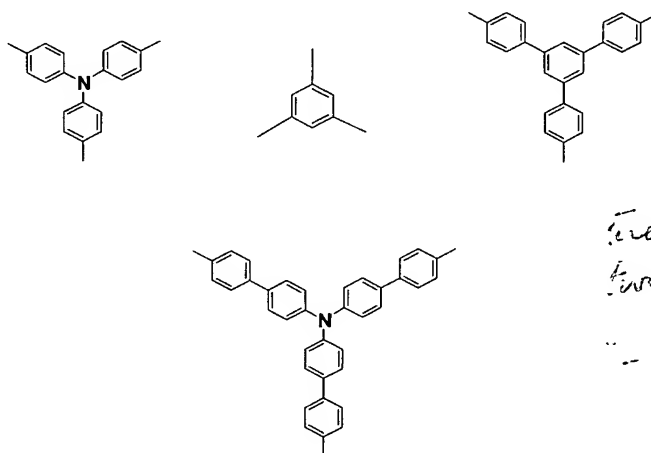
R19-R22 are same or different and are selected from alkyl, heteroalkyl, aryl, arylalkyl, heteroaryl, heteroarylalkyl, and N R⁵,

5 R⁵ is H or an alkyl; and

o and p are numbers of substituents on the benzene rings and are same or different and each of o and p is in a range of 0-3.

10 19. An electronic device according to Claim 7, wherein the second monomeric unit is a branching monomeric unit having more than two linkage sites.

20. An electronic device according to Claim 19, wherein the second monomeric unit is selected from to:



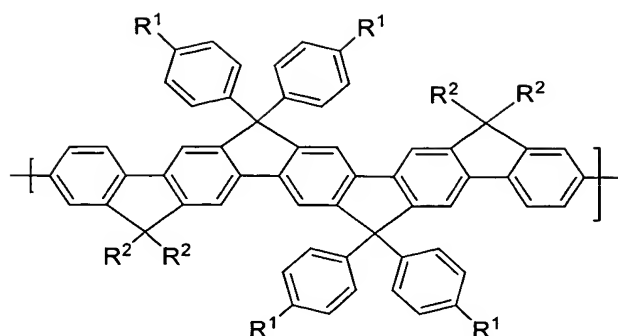
15

20. ²¹ An electronic device comprising an active layer positioned between two electrical contact layers, wherein the active layer comprises a copolymer having the formula:

20 —(first monomeric unit)_q—(ED unit)_r—(SE unit)_s—(HT unit)_t—(branching unit)_u—

wherein:

the first monomeric unit has Formula I:



(I)

wherein:

R^1 is the same or different at each occurrence and is selected from hydrogen, C_1 - C_{20} alkyl, C_2 - C_{20} alkenyl, C_2 - C_{20} alkynyl, C_1 - C_{20} alkoxy, C_1 - C_{20} oxyalkyl, C_2 - C_{20} oxyalkenyl, C_2 - C_{20} oxyalkynyl, C_1 - C_{20} fluorinated alkyl, C_2 - C_{20} fluorinated alkenyl, C_1 - C_{20} fluorinated oxyalkyl, C_2 - C_{20} fluorinated oxyalkenyl, C_2 - C_{20} fluorinated oxyalkynyl, aryl, heteroalkyl, heteroalkenyl, heteroalkynyl, heteroaryl, -CN, -OR³, -CO₂R³, -SR³, -N(R³)₂, -P(R³)₂, -SOR³, -SO₂R³, and -NO₂; or adjacent R groups together can form a 5- or 6-membered cycloalkyl, aryl, or heteroaryl ring,

R^2 is the same or different at each occurrence and is selected from C_1 - C_{20} alkyl, C_2 - C_{20} alkenyl, C_2 - C_{20} alkynyl, C_1 - C_{20} alkoxy, C_1 - C_{20} oxyalkyl, C_2 - C_{20} oxyalkenyl, C_2 - C_{20} oxyalkynyl, C_1 - C_{20} fluorinated alkyl, C_2 - C_{20} fluorinated alkenyl, C_1 - C_{20} fluorinated oxyalkyl, C_2 - C_{20} fluorinated oxyalkenyl, C_2 - C_{20} fluorinated oxyalkynyl, heteroalkyl, heteroalkenyl, heteroalkynyl, -CN, -OR³, -CO₂R³, -SR³, -N(R³)₂, -P(R³)₂, -SOR³, -SO₂R³, and -NO₂; or adjacent R groups together can form a 5- or 6-membered cycloalkyl or heterocycloalkyl ring, and

R^3 is a substituent on a heteroatom which can be the same or different at each occurrence and is selected from hydrogen, alkyl, aryl, heteroalkyl and heteroaryl;

the ED unit has a formula -Y-Z-Y- wherein:

Y is an aromatic group with at least one substituent selected from alkyl, heteroalkyl, aryl, arylalkyl, heteroaryl, heteroarylalkyl, and NR⁵, R^5 is H or an alkyl; and

Z is an electron deficient group;

the HT unit is a monomeric unit having hole transport properties;

the SE unit is selected from substituted fluorenes, substituted phenyls, substituted biphenyls, substituted bridged biphenyls, and combinations thereof;

5 the branching unit is a monomeric unit having more than two linkage sites;

q is an integer; and

r, s, t, and u are 0 or an integer, with the proviso that at least one of r, s, t, and u is an integer.

10